

Studies of Asteroids, Comets, and Jupiter's Outer Satellites

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Strategy

Our work comprises observational, theoretical, and computational research, mainly on asteroids. Two principal areas of research, centering on astrometry and photometry, are interrelated in their aim to study the overall structure of the asteroid belt and the physical and orbital properties of individual asteroids.

Progress and Accomplishments

Two highlights have been: (1) *Detection of CN emission from Chiron*. Bus *et al.* (1991) reported the first detection of gaseous emission from Chiron from observations made on 1990 January 29 and 30, breaking the record heliocentric distance for such cometary emission. They concluded that the outgassing is driven by isolated outbursts of a volatile species such as CO₂ or CO from a small fraction of Chiron's surface. (2) *Realization that 1990 MB is the first known Trojan-type asteroid of a planet other than Jupiter*. 1990 MB librates about Mars' L5, and evidently has a lifetime of at least tens of millions of years. This discovery will be a major challenge to solar system dynamicists, who will wish to determine whether 1990 MB is primeval and to explore more fully the regions of planetary Trojan stability; and to observers, who will wish to search for other planetary Trojans. Using films from the 46-cm Palomar Schmidt to discover and follow up moderately bright asteroids (the GLAS survey), several thousand positions of known and unknown asteroids were published. We have secured accurate astrometry of CRAF target P/Kopff on a monthly basis, and have continued prolific astrometric measurement of archive plates. CCD astrometry of very faint asteroids has been applied mainly to the follow-up and orbit improvement of Earth-approachers. The Lowell Observatory-U.K. Schmidt Telescope Asteroid Survey (LUKAS) has proceeded slowly. Our work to acquire rotational and shape statistics on km-size asteroids has continued with CCD observations of several targets. Using archival photographic plates, we have worked on the historical light variation of Chiron. Many asteroid orbits have been calculated, and asteroid identification work has proceeded apace. A new method of asteroid orbital error analysis, based on Bayesian theory, has been developed. Work on the spatial and sky-plane distributions of main-belt and near-Earth asteroids was started. Theoretical modeling of asteroid photometry has resulted in preparation of a major paper on "Photomorphography". Work on a spherical harmonics method of determining asteroid spin vectors and on light scattering by dust has resulted in published papers.

Projected Accomplishments

We will focus our astrometric effort in three principal areas: (1) LUKAS. Completion of the comparison of two Trojan fields with digital sky survey data should result in publication of several hundred 2-month-arc orbits, including perhaps 30 Trojan orbits. We will undertake further software development for linkage and identification that will cope with the large data throughput. We also hope to expand the scope of LUKAS to encompass the acquisition of spectra for faint asteroids. Four test objective-prism plates, two of which may contain as many as 300 physically diagnostic spectra, are in hand. (2) GLAS. We will be exploring ways of semi-automatically extracting long-arc orbits for many hundreds of relatively bright asteroids per year. (3) We will start to create a faint-asteroid positional database, initially by extracting asteroid positions from the digitized U.K. Schmidt Sky Survey. We will complete the study of Chiron's historical brightness variations. CCD astrometry and photometry of selected asteroids (close-Earth-approachers, Chiron, targets for rotational statistics) will continue as before. The work on orbital error analysis will be brought to a conclusion, and work will continue on the spatial distribution of asteroids. A study of the interpretation of asteroid motion vectors will be resuscitated. Work on the theoretical interpretation of asteroid photometry will shift to a thorough analysis of rotation period determination.

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